THE EFFECT OF BENZIMIDAZOLE ON THE RESPIRATION OF EXCISED WHEAT ROOTS

by

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The imidazole ring is a constituent part of all purines and ubiquinons in nature. The effect of certain azole compounds on growth and development of plant roots was studied in some earlier experiments. These experiments suggested that benzazole compounds had certain antimetabolic properties. Benzimidazole inhibits the auxin induced elongation in epicotyl sections of pea (Galston et al. 1953) and decreases the cell division in onion root meristem and in yeast (Duncan et al. 1953). In 1 millimole concentration benzimidazole causes a 50 per cent repression of the elongation of the primary roots in cucumber, and accelerates the development of piths on tomato stems in tissue culture. Woolley (1941) found that benzimidazole was an antimetabolite of purines, especially of adenine. Mc Corquodale and Duncan (1957) found that the inhibition of root elongation by benzimidazole was not a purine-antimetabolite interference, but that the primary effect of benzimidazole on growth and development was due to an interaction with other metabolic systems. Klingensmith (1961) verified that benzimidazole and analog compounds to it may interact with some metabolic systems in which indole or indole derivates have an essential role.

Person et al. (1957) found that benzimidazole inhibited the breakdown of proteins and chlorophyll in excised wheat leaves. Similarly to benzimidazole kinetin and 6-benziladenine increase the resistance to rust infection in monocotyledonous plants (Samborski et al.). Kapoor and Waygood (1965) verified that benzimidazole was converted into nucleotid-type compounds in plants. Pozsár et al. (1967) proved that benzimidazole caused delayed senescence not only in monocotyledonous but also in dicotyledonous plants. Benzimidazole increased resistance against TMV virus in tobacco leaves (El Hammady 1968). Therefore it is commonly suggested that benzimidazole is a compound with typical cytokinin activity in leaves.

The purpose of this work is to investigate the effect of benzimidazole on oxygen consumption and on reducing sugar content of excised wheat roots.

Material and methods

Wheat seeds were germinated and cultivated in 5 m. eqv. $CaSO_4$ solution continously in dark at 25°C. The roots of 5 day old wheat seedlings were carefully excised. After excision the roots were washed and aired continously in various test solutions at 25°C. The experiment took about 6 hours following excision. The measurements of the intensity of respiration were carried out immediately upon excision and every second hour. Oxygen consumption was determined by the Warburg method. Paralell with investigations of the oxygen uptake of the tissues, we examined the changes of reducing sugar content in excised wheat roots taken as a function of time. The reducing sugar content was determined by means of anthron reagent. The optical density of solution was measured at 610 mu with a Spektromom 360 spectrophotometer. The experiments were carried out with 3 – 5 repetitions.

Discussion

The intensity of oxygen consumption decreased after excision. In the first and second hours upon excision a decreasing tendency appeared. Afterwards it showed a slow increase and decreased again at the end of the experiments. The depressed oxygen uptake was caused in the first place the exhaustion of the respiratory substrates (E l i a s s o n 1955). By addition of exogene glucose the depression of oxygen uptake may be inhibited. In our experiments the reducing sugar content rapidly decreased in the first part of the excision. In the second part of the experiments the rate of depression was lower.

1 mM benzimidazole moderated the rapid decrease of oxygen uptake measured at the beginning of excision. The intensity of respiration shows a linear depression at roots treated with benzimidazole. Respiration decreases continously but slower than at control during the first and second hours after excision. At the end of the experiments reached the level of the control. The cytokinin activity of benzimidazole is generally proved. As generally known benzimidazole inhibits the expansion of cells. Probably also here this compound stunted the elongation and senescence of meristem and moderated decrease of oxygen uptake through a regulation of the amount of respiratory substrates. Therefore we investigated the effect of benzimidazole on the reducing sugar content is meristem- and elongating cells as well as in older tissues of the roots. The reducing sugar content is considerable in the apex of the roots. In older parts of the roots the amount of reducing sugars is smaller. Benzimidazole affected the reducing sugar content in the meristem and in the growing tissues in various ways. In the meristem it inhibited the breakdown of sugars at the beginning of the excision, and reserved the metabolic condition characteris-

tic of young tissues. In older parts of roots the effect of benzimidazole could not be demonstrated. So this compound probably reduces the decrease of respiration by regulating the quantity of respiratory substrates in the apex. It either inhibits the breakdown of glucose, or mobilizes endogene reducing sugar pools. It is known that kinetin causes an increase in reducing sugars in excised barley leaves (D é z s i – F a r k a s 1967.), however no clear explanation of this effect is known. In the experiments reported above, the author has demonstrated, that benzimidazole inhibited the breakdown of reducing sugars after excision also in wheat roots. In this way he demonstrated the cytokinin activity of benzimidazole in a novel respect.

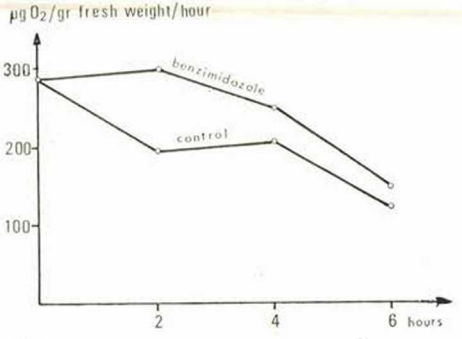

Figure 1. The effect of benzimidazole on the oxygen consumption of excised wheat roots

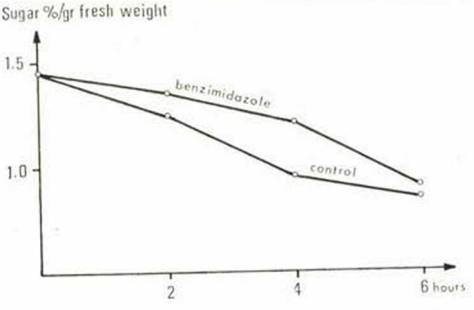

Figure 2. The time course of change of reducing sugar content in the apical part (0 – 5 mm) of wheat roots after excision

Summary

Investigations were carried out on the effect of benzimidazole on the respiration of excised wheat roots. The intensity of respiration decreased at the time of excision. 1 mM benzimidazole moderated the rapid decrease of oxygen consumption at the beginning of the excision. Also the exhaustion of reducing sugars in the apex of roots was lessend. In older tissues of the roots benzimidazole was ineffective. The depression of respiration following excision was caused, in the first place, by the fact, that the pool of respiratory substrates in the meristem was exhausted.

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